

## Claims

What is claimed is:

Claim 1. A method of horizontally structured CAD/CAM manufacturing, comprising:

selecting a blank for machining into an actual part:

establishing a coordinate system;

5 creating a master process model comprising:

a virtual blank corresponding to said blank;

a manufacturing feature;

virtual machining of said manufacturing feature into said virtual blank, said manufacturing feature exhibiting an associative relationship

10 with said coordinate system; and

generating machining instructions to create said actual part by machining said manufacturing feature into said blank.

Claim 2. The method of Claim 1 wherein said associative relationship is a parent/child relationship.

Claim 3. The method of Claim 1 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 4. The method of Claim 3 wherein said associative relationship is a parent/child relationship.

Claim 5. The method of Claim 1 wherein said virtual blank exhibits an associative relationship with another said manufacturing feature.

Claim 6. The method of Claim 5 wherein said associative relationship is a parent/child relationship.

Claim 7. The method of Claim 1 wherein said virtual blank exhibits an associative relationship with said coordinate system.

Claim 8. The method of Claim 7 wherein said associative relationship is a parent/child relationship.

Claim 9. The method of Claim 1 further comprising creating extracts from said master process model.

Claim 10. The method of Claim 9 wherein said extracts comprise replicated models of said master process model at various operations of said manufacturing.

Claim 11. The method of Claim 9 wherein said extracts exhibit an associative relationship with said master process model.

Claim 12. The method of Claim 9 wherein said associative relationship is a parent/child relationship.

Claim 13. The method of Claim 9 wherein said extracts are used to generate manufacturing process sheets.

Claim 14. The method of Claim 1 wherein said virtual blank is positioned and oriented relative to said coordinate system.

Claim 15. The method of Claim 14 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 16. The method of Claim 15 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 17. The method of Claim 1 wherein establishing said coordinate system comprises one or more datum planes.

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Claim 18. The method of Claim 1 wherein said coordinate system comprises:

creating a first datum plane positioned and oriented relative to a reference;

5 creating a second datum plane positioned and oriented relative to said reference; and

creating a third datum plane positioned and oriented relative to said reference.

Claim 19. The method of Claim 18 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

Claim 20. The method of Claim 1 wherein said manufacturing instructions comprise process sheets.

Claim 21. The method of Claim 20 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 22. The method of Claim 1 wherein said master process model is linked with numerically controlled tools and a coordinate measuring machine.

Claim 23. The method of Claim 1 wherein said associative relationship is a parent/child relationship.

Claim 24. The method of Claim 23 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 25. The method of Claim 24 wherein said associative relationship is a parent/child relationship.

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Claim 26. The method of Claim 25 wherein said virtual blank exhibits an associative relationship with another said manufacturing feature.

Claim 27. The method of Claim 26 wherein said associative relationship is a parent/child relationship.

Claim 28. The method of Claim 27 wherein said virtual blank exhibits an associative relationship with said coordinate system.

Claim 29. The method of Claim 28 wherein said associative relationship is a parent/child relationship.

Claim 30. The method of Claim 29 further comprising creating extracts from said master process model.

Claim 31. The method of Claim 30 wherein said extracts comprise replicated models of said master process model at various operations of said manufacturing.

Claim 32. The method of Claim 31 wherein said extracts exhibit an associative relationship with said master process model.

Claim 33. The method of Claim 32 wherein said associative relationship is a parent/child relationship.

Claim 34. The method of Claim 33 wherein said extracts are used to generate manufacturing process sheets.

Claim 35. The method of Claim 34 wherein said virtual blank is positioned and oriented relative to said coordinate system.

Claim 36. The method of Claim 35 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 37. The method of Claim 36 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 38. The method of Claim 37 wherein establishing said coordinate system comprises one or more datum planes.

Claim 39. The method of Claim 38 wherein said coordinate system comprises:

creating a first datum plane positioned and oriented relative to a reference;

5 creating a second datum plane positioned and oriented relative to said reference; and

creating a third datum plane positioned and oriented relative to said reference.

Claim 40. The method of Claim 39 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

Claim 41. The method of Claim 40 wherein said manufacturing instructions comprise process sheets.

Claim 42. The method of Claim 41 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 43. The method of Claim 42 wherein said the master process model is linked with numerically controlled tools and a coordinate measuring machine.

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Claim 44. The method of Claim 1 further including modifying a link among a plurality of modeling elements.

Claim 45. The method of Claim 44 wherein said link comprises an associative relationship.

Claim 46. The method of Claim 45 wherein said associative relationship is a parent/child relationship.

Claim 47. The method of Claim 44 wherein said modifying comprises removing said link among said modeling elements.

Claim 48. The method of Claim 44 wherein said modifying comprises establishing said link among said modeling elements.

Claim 49. The method of Claim 44 wherein said modifying links among modeling elements includes substituting a second plurality of modeling elements for said plurality of modeling elements.

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Claim 57. The manufactured part of Claim 56 wherein said associative relationship is a parent/child relationship.

Claim 58. The manufactured part of Claim 50 further comprising extracts created from said master process model.

Claim 59. The manufactured part of Claim 58 wherein said extracts comprise replicated models of said master process model at various operations of said manufacturing.

Claim 60. The manufactured part of Claim 58 wherein said extracts exhibit an associative relationship with said master process model.

Claim 61. The manufactured part of Claim 58 wherein said associative relationship is a parent/child relationship.

Claim 62. The manufactured part of Claim 58 wherein said extracts are used to generate manufacturing process sheets.

Claim 63. The manufactured part of Claim 50 wherein said virtual blank is positioned and oriented relative to said coordinate system.

Claim 64. The manufactured part of Claim 63 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 65. The manufactured part of Claim 64 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 66. The manufactured part of Claim 50 wherein said coordinate system comprises one or more datum planes.



Claim 67. The manufactured part of Claim 50 wherein said coordinate system comprises:

a first datum plane positioned and oriented relative to a reference;

5 a second datum plane positioned and oriented relative to said reference; and

a third datum plane positioned and oriented relative to said reference.

Claim 68. The manufactured part of Claim 67 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

Claim 69. The manufactured part of Claim 50 wherein said manufacturing instructions comprise process sheets.

Claim 70. The manufactured part of Claim 69 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 71. The manufactured part of Claim 50 wherein said master process model is linked with numerically controlled tools and a coordinate measuring machine.

Claim 72. The manufactured part of Claim 50 wherein said associative relationship is a parent/child relationship.

Claim 73. The manufactured part of Claim 72 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 74. The manufactured part of Claim 73 wherein said associative relationship is a parent/child relationship.

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Claim 75. The manufactured part of Claim 74 wherein said virtual blank exhibits an associative relationship with another said manufacturing feature.

Claim 76. The manufactured part of Claim 75 wherein said associative relationship is a parent/child relationship.

Claim 77. The manufactured part of Claim 76 wherein said virtual blank exhibits an associative relationship with said coordinate system.

Claim 78. The manufactured part of Claim 77 wherein said associative relationship is a parent/child relationship.

Claim 79. The manufactured part of Claim 78 further comprising extracts created from said master process model.

Claim 80. The manufactured part of Claim 79 wherein said extracts comprise replicated models of said master process model at various operations of said manufacturing.

Claim 81. The manufactured part of Claim 80 wherein said extracts exhibit an associative relationship with said master process model.

Claim 82. The manufactured part of Claim 81 wherein said associative relationship is a parent/child relationship.

Claim 83. The manufactured part of Claim 82 wherein said extracts are used to generate manufacturing process sheets.

Claim 84. The manufactured part of Claim 83 wherein said virtual blank is positioned and oriented relative to said coordinate system.

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Claim 85. The manufactured part of Claim 84 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 86. The manufactured part of Claim 85 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 87. The manufactured part of Claim 86 wherein said coordinate system comprises one or more datum planes.

Claim 88. The manufactured part of Claim 87 wherein said coordinate system comprises:

- a first datum plane positioned and oriented relative to a reference;
- 5 a second datum plane positioned and oriented relative to said reference; and
- a third datum plane positioned and oriented relative to said reference.

Claim 89. The manufactured part of Claim 88 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

Claim 90. The manufactured part of Claim 89 wherein said manufacturing instructions comprise process sheets.

Claim 91. The manufactured part of Claim 90 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 92. The manufactured part of Claim 91 wherein said the master process model is linked with numerically controlled tools and a coordinate measuring machine.

Claim 93. The manufactured part of Claim 50 further includes a modifiable link among a plurality of modeling elements.

Claim 94. The manufactured part of Claim 93 wherein said link comprises an associative relationship.

Claim 95. The manufactured part of Claim 94 wherein said associative relationship is a parent/child relationship.

Claim 96. The manufactured part of Claim 93 wherein said modifiable link is removed from among said modeling elements.

Claim 97. The manufactured part of Claim 93 wherein said modifiable link is established among said modeling elements.

Claim 98. The manufactured part of Claim 93 wherein said modifiable link among modeling elements includes a substituted second plurality of modeling elements for said plurality of modeling elements.

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Claim 99. A storage medium encoded with a machine-readable computer program code for horizontally structured CAD/CAM manufacturing, said storage medium including instructions for causing a computer to implement a method comprising:

- 5                   selecting a blank for machining into an actual part;
- establishing a coordinate system;
- creating a master process model comprising:
  - a virtual blank corresponding to said blank;
  - a manufacturing feature;
- 10                  virtual machining of said manufacturing feature into said virtual blank, said manufacturing feature exhibiting an associative relationship with said coordinate system; and
- generating machining instructions to create said actual part by machining said manufacturing feature into said blank.

Claim 100. The storage medium of Claim 99 wherein said associative relationship is a parent/child relationship.

Claim 101. The storage medium of Claim 99 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 102. The storage medium of Claim 99 wherein said virtual blank exhibits an associative relationship with another said manufacturing feature.

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Claim 103. The storage medium of Claim 99 wherein said virtual blank exhibits an associative relationship with said coordinate system.

Claim 104. The storage medium of Claim 99 further comprising creating extracts from said master process model.

Claim 105. The storage medium of Claim 99 wherein said virtual blank is positioned and oriented relative to said coordinate system.

Claim 106. The storage medium of Claim 105 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 107. The storage medium of Claim 106 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 108. The storage medium of Claim 99 wherein establishing said coordinate system comprises one or more datum planes.

Claim 109. The storage medium of Claim 99 wherein said coordinate system comprises:

creating a first datum plane positioned and oriented relative to a reference;

5 creating a second datum plane positioned and oriented relative to said reference; and

creating a third datum plane positioned and oriented relative to said reference.

Claim 110. The storage medium of Claim 109 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

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Claim 111. The storage medium of Claim 99 wherein said manufacturing instructions comprise process sheets.

Claim 112. The storage medium of Claim 111 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 113. The storage medium of Claim 99 wherein said master process model is linked with numerically controlled tools and a coordinate measuring machine.

Claim 114. The storage medium of Claim 99 wherein said associative relationship is a parent/child relationship.

Claim 115. The storage medium of Claim 114 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 116. The storage medium of Claim 99 further including modifying a link among a plurality of modeling elements.

Claim 117. The storage medium of Claim 116 wherein said link comprises an associative relationship.

Claim 118. The storage medium of Claim 117 wherein said associative relationship is a parent/child relationship.

Claim 119. The storage medium of Claim 116 wherein said modifying comprises removing said link among said modeling elements.

Claim 120. The storage medium of Claim 116 wherein said modifying comprises establishing said link among said modeling elements.

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Claim 121. The storage medium of Claim 116 wherein said modifying links among modeling elements includes substituting a second plurality of modeling elements for said plurality of modeling elements.

Claim 122. A computer data signal for horizontally structured CAD/CAM manufacturing, said computer data signal comprising code configured to cause a processor to implement a method comprising:

- selecting a blank for machining into an actual part;
- 5 establishing a coordinate system;
- creating a master process model comprising:
  - a virtual blank corresponding to said blank;
  - a manufacturing feature;
  - virtual machining of said manufacturing feature into said
- 10 virtual blank, said manufacturing feature exhibiting an associative relationship with said coordinate system; and
- generating machining instructions to create said actual part by machining said manufacturing feature into said blank.

Claim 123. The computer data signal of Claim 122 wherein said associative relationship is a parent/child relationship.

Claim 124. The computer data signal of Claim 122 further including another manufacturing feature exhibiting an associative relationship with said manufacturing feature.

Claim 125. The computer data signal of Claim 122 wherein said virtual blank exhibits an associative relationship with another said manufacturing feature.

Claim 126. The computer data signal of Claim 122 wherein said virtual blank exhibits an associative relationship with said coordinate system.

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Claim 127. The computer data signal of Claim 126 wherein said associative relationship is a parent/child relationship.

Claim 128. The computer data signal of Claim 122 further comprising creating extracts from said master process model.

Claim 129. The computer data signal of Claim 122 wherein said virtual blank is positioned and oriented relative to said coordinate system.

Claim 130. The computer data signal of Claim 129 wherein said virtual blank is generated as a three dimensional parametric solid model from a reference set geometry.

Claim 131. The computer data signal of Claim 130 wherein said reference set geometry is defined by dimensional characteristics of a modeled part.

Claim 132. The computer data signal of Claim 122 wherein establishing said coordinate system comprises one or more datum planes.

Claim 133. The computer data signal of Claim 122 wherein said coordinate system comprises:

- creating a first datum plane positioned and oriented relative to a reference;
- 5       creating a second datum plane positioned and oriented relative to said reference; and
- creating a third datum plane positioned and oriented relative to said reference.

Claim 134. The computer data signal of Claim 133 wherein said first datum plane, said second datum plane, and said third datum plane are orthogonal.

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Claim 135. The computer data signal of Claim 122 wherein said manufacturing instructions comprise process sheets.

Claim 136. The computer data signal of Claim 135 wherein said process sheets are linked with numerically controlled tools and a coordinate measuring machine.

Claim 137. The computer data signal of Claim 122 wherein said master process model is linked with numerically controlled tools and a coordinate measuring machine.

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